Midwives’ Cell Phone Use and Health Knowledge in Rural Communities

SEUNGYOON LEE
Department of Communication, Purdue University, West Lafayette, Indiana, USA

ARUL CHIB
Wee Kim Wee School of Communication and Information, Nanyang Technological University, Singapore

JEONG-NAM KIM
Department of Communication, Purdue University, West Lafayette, Indiana, USA

This study developed and tested a theoretical model that explains the underlying process through which the use of cell phones can facilitate the capacity of community health care workers in developing regions. On the basis of a study conducted on 223 midwives in rural regions of Indonesia, the results showed that cell phone use was positively associated with midwives’ access to institutional and peer information resources. Access to institutional resources was positively associated with midwives’ health knowledge. Further, access to peer resources was associated with higher self-efficacy, which was positively associated with health knowledge. The study provides implications for technology intervention strategies targeted to community health workers in rural communities.

Decentralized and accessible health knowledge has been one of the prominent goals of primary health care in developing countries. Yet, lack of knowledge and information remains a significant deterrent to health practices, leading to heightened health risk (e.g., Kargbo, 2008; Rhine, 2006). In particular, individuals often lack direct access to health institutions and services due to geographical, economic, and social barriers. Therefore, community health workers (CHWs, also referred to as village health workers) in developing countries are critical intermediaries between higher level health institutions and the community in need of medical care (Batchelor et al., 2003; Iluyemi, Fitch, Parry, & Briggs, 2007; Mchombu, 2003). Consequently, health-related knowledge of CHWs is an essential resource for the improvement of health care quality. Although a number of studies have examined predictors of information and knowledge acquisition in various health contexts (e.g., Guerra,

This study was supported by World Vision Indonesia. The authors thank Peng Hwa Ang, Peter Monge, and Namkee Park for their suggestions on earlier drafts of this article.

Address correspondence to Seungyoon Lee, Department of Communication, Purdue University, 100 N. University Street, BRNG 2114, West Lafayette, IN 47907, USA. E-mail: seungyoon@purdue.edu
Dominguez, & Shea, 2005; Muturi, 2005), research that involves CHWs remains scarce.

Interest has been growing in the idea that information and communication technologies could extend the reach of remote CHWs in providing medical services. Studies suggested that facilitating information and communication technology access could enable rapid and sustainable gains in healthcare delivery. In particular, cell phone devices and applications could provide beneficial results (Bali & Singh, 2007; Mirza & Norris, 2007). Two primary benefits of cell phone accessibility are the ability of remote CHWs to access advice and information from experts, and the ability to access and deliver health records from and into the medical information system. The literature lists instances of both referral systems (Sherwani et al., 2007) and medical records systems (Kinkade & Verclas, 2008).

Given the increased attention to information and communication technologies, the goal of this study is to examine the underlying processes through which they can have a positive influence on CHWs’ health knowledge in a developing country setting. The present study attempts to address this issue in the context of midwives’ cell phone use in rural communities. In particular, the study examines the association between cell phone use and midwives’ access to resources, as well as their self-efficacy. In other words, this study proposes a theoretical framework to examine information and communication technology use and health outcomes, focusing on sociostructural (resources) and cognitive (self-efficacy) predictors that are associated with health knowledge.

The present study is conducted in the context of maternal and infant health practices in rural Indonesia. The empirical setting provides a unique opportunity to test the theoretical framework. First, CHWs such as midwives perform significant functions in developing countries, including pregnancy care, emergency obstetric care, management of infant illness, and improvement of nutrition (Haines et al., 2007). Thus, knowledge held by CHWs plays a critical role in health practices. Knowledge is an important indicator of health outcome, potentially leading to changes in health behavior (Stephens, Rimal, & Flora, 2004). Past literature suggests that knowledge increases individuals’ capability to critically assess health-related issues, thus leading to the formation of positive health attitudes and behaviors (e.g., Jallinoja & Aro, 2000; Rose, Peters, Shea, & Armstrong, 2005). Second, rural Indonesia provides a useful context because it has shown a rapid growth of cell phone penetration (International Telecommunications Union, 2007; Telecom Asia, 2007). With such growth combined with gains in economic affordability, the use of everyday mobile technologies will become increasingly popular among CHWs (for a review, see United Nations, 2007).

**Cell Phone Use and Access to Resources**

Along with a variety of health intervention efforts to promote health knowledge, recent studies have evidenced the potential of information and communication technologies. Studies have examined the role of information and communication technologies in facilitating the improvement of health outcome in various domains, including knowledge, attitude, and behavior (e.g., Grigsby, 2002; Matusitz & Breen, 2007; Suggs, 2006). A well-established set of literature claims that the core role of information and communication technologies in developing communities is enhanced communication and connectivity (e.g., The Wireless Internet Institute,
In rural settings, studies have focused on telehealth and telemedicine such as video conferencing (Nesbitt, Marcin, Daschbach, & Cole, 2005) as well as technological devices and applications in hospitals (Casey, Moscovice, & Davidson, 2006). Recently, information and communication technologies such as cell phones have proven to be effective in rural and remote environments by providing benefits such as low-cost deployment, flexible infrastructure, and community-shared resources. Studies have indicated that cell phones can be adopted as an effective tool for health intervention (Husler, 2005; Kaplan, 2006).

In line with this set of literature, this study suggests that one way midwives’ use of cell phones may be useful is by improving access to health-related resources. Specifically, two types of resources need to be distinguished: formal resources, which reside in health institutions or medical professionals; and informal resources, which can be drawn from peer workers. Cell phone eases midwives’ access to health information and they can easily seek professional support in the healthcare system (Chib, Lwin, Ang, Lin, & Santoso, 2008). Especially given the geographic sparseness and lack of transportation infrastructure, timely access to community health resources has been considered as critical in rural communities. At the same time, informal resources are particularly relevant to developing communities where social contacts are based on tight-knit relations. Use of cell phones is expected to enhance communication and interaction among peer health workers. In summary, we hypothesized that use of cell phone will help midwives better use their resources:

Hypothesis 1: Midwives’ cell phone use is positively associated with their access to (a) institutional and (b) peer resources.

Determinants of Health Knowledge

Sociostructural Determinants: Institutional and Peer Resources

It has been a long-standing pursuit to establish a comprehensive model that takes into account individual and social factors that affect health outcomes. In particular, scholars have argued that previous approaches to health promotion have largely focused on individual cognitive determinants, often neglecting the social structure that surrounds those individuals (Green, Richard, & Potvin, 1996; Patrick, Intille, & Zabinski, 2005; Sallis & Owen, 2002). Because individuals are not isolated from social structure, the way in which they are embedded in institutions or groups is likely to influence their knowledge and behavior. Past literature has identified the importance of interpersonal sources of information and communication in behavior change (e.g., Chaffee, 1982; Hornik, 1989), such as the influence of peers on sexual attitudes and behavior (Chia, 2006) and adolescent smoking behaviors (Gunther, Bolt, Borzekowski, Liebhart, & Dillard, 2006). The effects of personal networks on the processes of health behavior change have been also suggested (e.g., Boer & Westhoff, 2006; Bond, Valente, & Kendall, 1999; Rogers & Kincaid, 1981; Valente & Saba, 1998). For example, in a study on the use of contraception for family planning in Bolivia, Valente and Saba (1998) found that the extent to which individuals are exposed to messages through their personal networks was more strongly associated with behavior change compared to the effect of mass-media campaigns. Further, Viswanath and Emmons (2006) studied how message effects can be moderated and mediated by social factors such as class, organizations, and neighborhoods.
As suggested earlier, two types of resources exist: formal resources, which reside in health institutions; and informal resources, which can be drawn from peer health workers. First, formal resources refer to medical help and information from health institutions including doctors and professionals. Second, informal resources involve those obtained from peer workers. Bandura (1986) argued that the number and patterns of social linkages influence the conveyance of information. Further, Mphahlele and Maepa (2003) found that knowledge is transmitted through social networks to a larger extent in rural communities. Further, as Valente and Saba (1998) suggested, discussion among network members can enhance knowledge about health topics. Therefore, if midwives have better access to formal and informal resources, they are more likely to acquire health knowledge from the interactions. Therefore:

Hypothesis 2: Access to (a) institutional resources and (b) peer resources is positively associated with midwives’ health knowledge.

**Cognitive Determinants: Self-Efficacy**

The role of self-efficacy has been emphasized in the context of health communication to a great extent. Bandura (2003) suggested that given similar circumstances, self-efficacious individuals have greater perceptions and beliefs about their abilities. Self-efficacy thus becomes a critical determinant in acquisition of knowledge and skills, motivation, and performance accomplishment. Rimal (2000) showed that people with higher self-efficacy are more likely to perform and sustain health behaviors than those with low self-efficacy. For example, self-efficacy of adolescents increased their resistance to negative peer pressure (Haignere, Freudenberg, Silver, Maslanka, & Kelley, 1997).

Social cognitive theory suggests that acquisition of knowledge, attitude, and behavior are mediated through individuals’ cognition (Bandura, 1986). In this sense, the role of self-efficacy has been examined in the domain of health information and knowledge. Studies suggested that self-efficacy had significant effects on health-information seeking. For example, more self-efficacious individuals achieve more accurate health information and attitudes (Rimal, 2000, 2001) and subsequent actions (Rimal & Real, 2003). Rains (2008) also argued for the role of self-efficacy in Internet-based health information seeking. Self-efficacy has also been found as an important determinant of breast cancer knowledge (Chen, Diamant, Thind, & Maly, 2008).

A majority of previous research in self-efficacy has examined its effects on patients, such as in studies ranging from self-care (Wu et al., 2007), adoption of health behaviors (Maibach, Flora, & Nass, 1991), and presumed influence (Gunther & Storey, 2006). Although the role of self-efficacy for CHWs is a critical issue in rural health, there are only a small number of studies that provide evidence for this issue. In a study of remote workers, Meyers and Hearn (2007) found that self-efficacy in contacting peer colleagues supported telework productivity. In the present study, the more CHWs attain self-efficacy about their perceived capabilities of mobilizing and using resources for accomplishing goals and dealing with problems, the more health knowledge they will have. Therefore:

Hypothesis 3: Midwives’ self-efficacy is positively associated with their health knowledge.
Bandura (2003) suggested previous experience as one of the factors that increases self-efficacy. As individuals acquire positive experiences of completing a task, they will become more confident about their perceived capability. Bandura (1995) also posited that an individual’s self-efficacy can be influenced through specific and targeted interventions. As individuals increase their exposure to health information and have greater information use and interaction with peers, they will become more aware of the issues and develop perceptions about their capabilities to use the resources. For example, a previous study found that users of Internet health information show higher levels of self-efficacy in terms of accomplishing positive cancer-related health behaviors compared with nonusers (Bass et al., 2006). In highly codependent environments such as those of remote CHWs, access to institutional resources as well as peer resources becomes vital. For example, by calling peer midwives about information needed for performing particular tasks, midwives will be able to develop confidence about their ability to solve problems. Past study has also suggested that access to critical medical information aids in establishing the authority of CHWs among community members (Ramachandran & Canny, 2008). Therefore, we proposed the following hypothesis:

Hypothesis 4: Access to (a) institutional and (b) peer resources is positively associated with midwives’ self-efficacy.

Method

Subjects: Midwives in Indonesia

Indonesia has a poor record in childbirth-related health statistics. The maternal mortality rate reaches up to 262 per 100,000 births (Analen, 2007) and infant mortality reaches up to 35 infant deaths per 100,000 live births (BAPPENAS, 2007). In Banda Aceh region in particular, lack of social infrastructure has become a significant problem since the 2004 tsunami (Chib, 2007).

Within the Indonesian context, the health service delivery system is organized at five levels: central, provincial, districts, subdistricts, and villages. *Puskesmas* (public health centers) at the subdistrict level deliver primary health care services via midwives, and are crucial for delivering maternal, newborn, and child health care. Growing attention has been paid to information and communication technologies, including cell phones, because they are expected to reduce health risks by improving the communication structure. This includes communication with senior midwives, obstetricians and community health institutions, access to information on handling complicated obstetrical cases, and transfer of routine health data to a central information system. Information and communication technologies could also help midwives organize transportation to the closest hospital in emergency.

We conducted a survey in November 2006 to assess midwives’ knowledge, health practices, technology use, resource use, self-efficacy, and demographics. Approximately 600 midwives work in Aceh Besar region associated with 22 medical centers. Participating midwives were stratified by their referral public health centers as defined by the partner midwife association, Iketan Bidan Indonesia. Data collection was performed on a total of 223 village midwives in 15 subdistricts of Aceh Besar.1

1The 15 subdistricts are Darul Imarah, Suka Makmur, Seulimum, Indra Puri, Kuta Malaka, Kahju, Kota Jantho, Lhoknga, Simpang Tiga, Ingin Jaya, Lhoong, Kota Cot Glie, Darul Kamal, Krueng Barona Jaya, and Darussalam.
The midwives who responded to the survey have been using cell phones for approximately 2.7 years on average. The average age of midwives who responded to the survey was 30 years. On average, the midwives have 7 years of midwifery work experience.

**Instrument and Measurement**

The survey was created on the basis of multiple sources. The questionnaire was translated into Bahasa Indonesian and administered by students hired from the local Aceh University. Training workshops for data collection and survey techniques were held for the entire team. Details on the measurement of each of the variables are subsequently explained.

**Cell Phone Use**

The extent of midwives’ cell phone use in general as well as for health information was measured by the following three items. First, midwives were asked about their frequency of cell phone use, reported on a 5-point scale ranging from 1 (never) to 5 (very often). Second, the extent to which midwives use a cell phone as a source of health information was asked: “How often have you obtained health information in the past 30 days from mobile phone?”, which was reported on a 5-point scale ranging from 1 (never) to 5 (very often). Third, midwives’ trust of health information obtained from a cell phone was asked: “How much do you trust the information about health from mobile phone,” followed by a 4-point scale ranging from 1 (not at all) to 4 (a lot), $\alpha = .65$.

**Access to Institutional Resources**

We measured access to institutional resources with the question, “When you need medical information for your work, how likely are you to turn to the following resources?” Institutional resources were divided into three types of health-related resources present in community institutions: health center personnel, gynecologist or doctor at hospital, and private gynecologist or doctor. The question was followed by a 5-point Likert-type scale ranging from 1 (not at all likely) to 5 (strongly likely), $\alpha = .75$.

**Access to Peer Resources**

Access to peer resources was operationalized by the frequency with which midwives obtained health information from people in the health center for advice about midwifery. The question measured the frequency of midwives talking to up to five people they identified as their contacts, reported on a 5-point scale ranging from 1 (never) to 5 (very often). A composite measure was obtained by averaging the frequency of access to these contacts ($\alpha = .77$).

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2Sources include the following: The Rapid Knowledge, Practices and Coverage Survey by the United States Agency for International Development; The Monitoring and Evaluation Toolkit by the Reproductive Health Response in Conflict Consortium; and the Maternal and Newborn Standards and Indicators Compendium by the United States Agency for International Development and CORE group.
Self-Efficacy
Efficacy was composed of eight items regarding midwives’ confidence about their abilities, which were drawn from Bandura’s (1986) suggested scales. The items specifically focused on their capability of accessing and using resources: “I feel confident that... I can use the health center for getting training related to my work”; “I can adequately use my training to deal with birth complications”; “The facilities/equipment provided to me are adequate to deal with birth complications”; “I can use the health center to get information for my work”; “I can store all the health data for my patients effectively”; “I can get a midwife coordinator to help me when I have a work problem”; “I can get another midwife to help me when I have a work problem”; “I can get a friend to help me when I have a work problem” (α = 75).

Health Knowledge
Knowledge related to substantive areas in maternal health practices was assessed in the areas of family planning practices, prenatal, and child delivery processes. Midwives were tested on a total of 34 questions (see the Appendix). Midwives’ responses to statements were reported on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). Items were listed in a way to make higher scores on a scale represent more accurate knowledge. A composite measure based on their average score was used as the indicator of health knowledge (α = .75).

Control Variables
Age and experience were included as control variables to test whether they influenced midwives’ health knowledge. Older midwives and those with longer work experiences may have acquired greater knowledge about health. Alternatively, age or experience could be associated with inaccurate knowledge derived from traditional beliefs and values. Test of the effects of age and experience on health knowledge was not significant, and therefore, the variables were excluded from the final model testing.

Analysis
Table 1 provides the correlations, means, and standard deviations of the variables incorporated in the final model testing. The hypothesized model presented in Figure 1 was analyzed using structural equation modeling techniques (Bollen, 1989; Byrne, 1998; Jöreskog & Sörbom, 1996) with EQS 6.1. The model was run as a structural model in which the observed model was compared to the hypothesized model to demonstrate how well they fit. To evaluate the proposed structural equation model, we adopted commonly used model fit indices: \( \chi^2 \) and its degree of freedom, comparative fit index, root mean square error of approximation, and standardized root mean square residual. To judge the adequacy of the model fit, we applied the Hu and Bentler (1999) joint-criteria approach. A model was considered tenable when it achieved or approached the following: (a) comparative fit index ≥ .96 and standardized root mean square residual ≤ .10 or (b) root mean square error of approximation ≤ .06 and standardized root mean square residual ≤ .10. When our model achieved a reasonable model-data fit, we interpreted its paths to evaluate the hypotheses.
Table 1. Means, standard deviations, and correlations of variables in the final model (N = 223)

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<tr>
<th>Variable</th>
<th>M (SD)</th>
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<tbody>
<tr>
<td>1. Cell phone use (frequency)</td>
<td>3.61 (0.88)</td>
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<td>2. Cell phone use (obtain health information)</td>
<td>2.54 (1.18)</td>
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<td>3. Cell phone use (trust health information)</td>
<td>2.53 (0.73)</td>
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<td>.42*</td>
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<td>4. Institutional resources (health center personnel)</td>
<td>4.17 (0.70)</td>
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<td>5. Institutional resources (gynecologist/doctor at hospital)</td>
<td>3.78 (0.93)</td>
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<td>6. Institutional resources (private gynecologist/doctor)</td>
<td>3.63 (0.92)</td>
<td>.12</td>
<td>.19*</td>
<td>.25*</td>
<td>.29*</td>
<td>.68*</td>
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<td>7. Peer resources</td>
<td>3.71 (.58)</td>
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<td>8. Self-efficacy (get training from health center)</td>
<td>4.31 (.63)</td>
<td>.03</td>
<td>.02</td>
<td>.04</td>
<td>.08</td>
<td>-.04</td>
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<td>9. Self-efficacy (training for birth complications)</td>
<td>4.16 (.78)</td>
<td>-.04</td>
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<td>.04</td>
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<td>10. Self-efficacy (facilities for birth complications)</td>
<td>4.27 (.86)</td>
<td>.01</td>
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<td>11. Self-efficacy (information from health center)</td>
<td>4.31 (.58)</td>
<td>.07</td>
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<td>-.01</td>
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<td>-.11</td>
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<td>12. Self-efficacy (health data storage)</td>
<td>4.31 (.69)</td>
<td>.05</td>
<td>-.01</td>
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<td>.12</td>
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<td>13. Self-efficacy (help from midwife coordinator)</td>
<td>4.24 (.69)</td>
<td>.14*</td>
<td>.05</td>
<td>.23**</td>
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<td>14. Self-efficacy (help from another midwife)</td>
<td>4.11 (.72)</td>
<td>.09</td>
<td>.06</td>
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<td>.25**</td>
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<td>.47**</td>
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<td>15. Self-efficacy (help from friend)</td>
<td>3.90 (.86)</td>
<td>.12</td>
<td>.06</td>
<td>.07</td>
<td>.20**</td>
<td>-.06</td>
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<td>16. Health knowledge</td>
<td>3.76 (.21)</td>
<td>.17*</td>
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<td>.10</td>
<td>.23**</td>
<td>.23**</td>
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*Note. $^*p < .05$. $^{**}p < .01$.*
Results

According to Hu and Bentler’s (1999) joint criteria, the structural model reached an acceptable level of model fit. Results for all paths are illustrated in Figure 2.

Hypothesis 1 expected positive relations between the extent of cell phone use and access to institutional (Hypothesis 1a) and peer (Hypothesis 1b) resources. We found support for both hypotheses: Hypothesis 1a: .52, \( p < .01 \) and Hypothesis 1b: .22, \( p < .05 \). In other words, midwives’ cell phone use was positively associated with access to institutional and peer-network resources.

The second set of hypotheses assumed positive associations between midwives’ access to institutional (Hypothesis 2a) and peer (Hypothesis 2b) resources and health knowledge...
knowledge. Hypothesis 2a was supported (.26, \( p < .001 \)) but Hypothesis 2b was not \((.00, ns)\). The results indicate that access to institutional resources had a direct positive effect on midwives’ health knowledge, while access to peer resources did not.

Hypothesis 3 expected a positive relation between self-efficacy and health knowledge. The results showed support \((.16, \ p < .05)\): self-efficacy was positively associated with midwives’ health knowledge. The next set of hypotheses predicted a positive association between access to institutional (Hypothesis 4a) and peer (Hypothesis 4b) resources and self-efficacy. The results indicated no support for Hypothesis 4a \((-.05, ns)\), but significant support for Hypothesis 4b \((.25, \ p < .001)\). In other words, midwives’ access to peer resources increased their self-efficacy, but access to institutional resources did not.

Further analysis suggested two significant mediation paths between midwives’ cell phone use and health knowledge. The two paths are as follows: through institutional resource access to health knowledge (Hypothesis 1a \(\times\) Hypothesis 2a) and through access to peer resources via self-efficacy to health knowledge (Hypothesis 1b \(\times\) Hypothesis 4b; Hypothesis 4b \(\times\) Hypothesis 3). Using Sobel’s mediation test procedure, we conducted three tests of mediation effects. For the first mediation effect of Hypothesis 1a \(\times\) Hypothesis 2a, an almost significant mediation effect was found: Sobel test statistic, 1.54 \((p = .061,\ \text{one-tailed})\). This result suggests that midwives’ access to institutional resource mediates the association between cell phone use and health knowledge. The second mediation effect (Hypothesis 1b \(\times\) Hypothesis 4b) was found to be significant: Sobel test statistic, 1.75 \((p = .040,\ \text{one-tailed})\). Last, the third mediation effect (Hypothesis 4b \(\times\) Hypothesis 3) was significant as well: Sobel test statistic: 1.77 \((p = .039,\ \text{one-tailed})\). The results support mediation effects between cell phone use and health knowledge through access to institutional resources, between cell phone use and self-efficacy through access to peer resources, and between access to peer resources and health knowledge through self-efficacy, while controlling for the effects of alternative paths.

Discussion

The major goal of this study was establishing and testing a theoretical model that explains the paths between cell phone use and health knowledge in rural communities. CHWs in developing countries create linkages between higher level health resources and patients. This study assessed whether cell phones play a beneficial role in this process, and further, whether the increased mobilization of resources was associated with better health knowledge. Overall, the results demonstrated the potential of cell phones for rural health care. Specifically, results show that cell phone use had a direct positive effect on midwives’ access to institutional and peer resources. As shown in the support for Hypotheses 1a and 1b, the study suggests that technologies with networking capability, such as cell phones, have the potential to facilitate communication between CHWs and higher institutions as well as among CHWs.

One of the goals of the study was to simultaneously examine the role of sociostructural and cognitive predictors of health knowledge held by midwives. The results suggested mixed support for the hypothesized relations. First, as shown in the testing of Hypotheses 2a and 2b, access to institutional resources was positively associated with health knowledge \((.26)\), while access to peer resources was not. These results indicate that the more midwives had access to institutional resources such as health centers and medical professionals, the more accurate their knowledge was.
This suggested the potential benefit of established channels through which community healthcare facilities can provide training and education to the midwives. The insignificant path between peer resources and knowledge merits consideration. The results suggest that although there might be potential support midwives can get through communicating with peer midwives, it was not necessarily translated into more accurate health knowledge. A number of studies show that in the realm of reproductive health and family planning, misconceptions and traditional notions have impeded health behavior and practices (Ferguson, 1991; Johansen, 2006; Muturi, 2005). The results of the present study suggest the importance of examining the accuracy of health knowledge held by midwives, providing proper education and training, and consequently, facilitating communication among peer midwives for the enhancement of health knowledge.

Another point to note is the support for Hypothesis 3. The results indicated that midwives’ confidence about their use of resources had a positive association with health knowledge. Previous studies had shown that more self-efficacious individuals are likely to engage in a higher level of information seeking and knowledge acquisition (Rains, 2008; Rimal, 2001). Altogether, this study added to the emphasis on the reciprocal relation between personal cognitive factors and behaviors (Bandura, 2003). The study also indicated that communicating with peer midwives had a positive effect on midwives’ perceived capabilities about their work, suggesting the potential social support generated through interaction among peer CHWs. Alternatively, while access to institutional resources did not have a significant association with self-efficacy beliefs (nonsupport for Hypothesis 4a), it had a direct association with health knowledge (support for Hypothesis 2a). In other words, social or emotional support among peer workers can be considered as an antecedent of midwives’ confidence, which is not obtainable through interaction with institutional sources of health information.

Another set of results from this study provides important theoretical understanding about cognitive processes of health knowledge. On the basis of social cognitive theory, the study suggests that use of technologies does not directly influence knowledge. Instead, they are mediated by individuals’ cognitive systems. This argument was supported in the case of peer resources. It is interesting to note that, as was represented in the Sobel tests, we found a notable mediation effect from cell phone use to midwives’ health knowledge. Specifically, there was a path between midwives frequent use of cell phone, midwives’ access to peer resources, midwives’ self-efficacy, and last, health knowledge held by midwives. This finding partly supports the propositions in social cognitive theory that individuals’ cognitions (e.g., self-efficacy) mediate the effects of social determinants (e.g., use of information and communication technologies) on individuals’ knowledge and attitudes.

This research provides several practical implications. In general, as emphasized in the call for theory-based health intervention strategies (Heeks, 2007), information and communication technology intervention projects need to be based not only on the investment of technologies but also on follow-up strategies for having them mobilized for relevant tasks. First, the present study showed that cell phones could be used as tools for better mobilizing resources via enhancing the communication structure within the community. Cell phones can provide successful experiences with accomplishing goals, in particular, in the context of facilitating access to peer resources. As such, it needs to be emphasized that the effectiveness of health system infrastructure designed to support CHWs is dependent on the ability of the individuals to access available resources.
Second, although advancements in telemedicine and telehealth have been rapid, there has been relatively less attention paid to the potential of information and communication technologies in everyday life. In particular, communication structure that links health workers with institutional and community resources is of critical importance. The implementation of health care technologies has often faced challenges in rural settings (Bahensky, Jaana, & Ward, 2008). One reason is the lack of economies of scale, which is caused by the limited number of patients as well as healthcare providers (Nesbitt et al., 2005). As research on health care information technology advances, the importance of understanding the social structure of community such as the communication activities among peer workers will become more important.

Last, this study emphasized the role of midwives as intermediaries connecting higher level health institutions to the local community. Considering the heavy reliance of local communities on midwives, the accuracy of health knowledge midwives hold about childbirth and family planning is critical to health risks such as mortality rates (Muturi, 2005). Further, negative effects from the presence of inaccurate health knowledge held by CHWs can be risky. Given the finding that midwives rely on peers for information, it is critical to enhance the knowledge of CHWs. Subsequently, facilitating the communication structure through which knowledge and resources can be shared will be essential for effective information and communication technology–based health interventions.

**Limitations and Future Research**

Interpretation of the aforementioned findings needs to be made with caution, due to several limitations. First, the dispersed and remote nature of the health environment in which the study was conducted needs to be considered. The disconnection between the midwives and the formal health infrastructure may be the reason for some of the findings, such as the rejection of Hypothesis 4a. Thus, it is to be noted that these findings may not be generalizable in a more contained health institutional setting and in more developed regions.

In this study, the effects of information and communication technologies on ultimate health outcome are left for further investigation. A considerable amount of research on the knowledge-attitude-behavior paradigm has been conducted in the field of health communication (Hornik, 1989). This body of research explains the mechanism through which knowledge acquisition and attitudinal changes lead to behavior changes (e.g., Ajzen & Fishbein, 1980; Valente, Paredes, & Poppe, 1998). Although this study examined health knowledge as a critical health outcome, they may not necessarily translate into behavior. An extended study setting in terms of scale and length of observation would allow such important investigations.

There are a few methodological limitations in the study. First, the study does not guarantee the representativeness of the sample because the subjects were recruited from a single region in Indonesia. Other rural communities may have unique characteristics in terms of CHWs and community health institutions. Second, the cross-sectional nature of the present study made it difficult to claim an overtime enhancement of health knowledge. If longitudinal data could be acquired, it would be worthwhile to examine whether cell phone use in a previous point of time affects resource access, self-efficacy, and knowledge at later time points. Third, measures in this study were based on self-reports, which may lead to social desirability bias. Future studies should consider including observed measures of these variables.
Despite these limitations, results from this study suggest a number of possibilities for future research. First, the present study largely focused on the use of cell phones as a basic voice-based communication tool. Yet, recent technological developments have opened up broader use of cell phones, such as health data transfer and information sharing. It is recommended that future studies consider these applications of cell phones. In addition, the theoretical framework developed in this study can be applied to other types of communication technologies, including the Internet and more recent wireless technologies.

Second, the results demonstrate the importance of communication among peer networks. To further examine this aspect, future studies are encouraged to examine these patterns of interaction through social network approaches and methodologies. A body of literature deals with this issue in rural health context (e.g., Valente, 1995). Such an approach would allow making a fine-grained assessment of structural position of individuals (e.g., centrality, brokerage, tie strength) and the overall network structure of a group of individuals (e.g., centralization, density, cliques, clusters). Further, a more concrete examination of the effects of social structure and influence on health-related processes can be made.

In summary, the present study demonstrates the importance of understanding the social dynamics of communities through which the design and evaluation of information and communication technology intervention projects can be improved. The unique research setting presented in the present study allowed us to highlight an underexamined area in health communication research: CHWs and their use of information and communication technologies. The framework and findings suggested in the study can provide a useful framework for future projects aiming to extend the benefits of information and communication technologies in reducing risks among pregnant women and children. In summary, this study added to the body of literature on the importance of theory-based design and evaluation of intervention projects (e.g., Fishbein & Cappella, 2006; Fishbein & Yzer, 2003) for effective health communication strategies.

References


Appendix

The following 34 questions were used to test midwives’ health knowledge. (R) indicates that the answers were reverse-coded so that higher score indicates more accurate health knowledge.

1. Family planning methods are effective to avoid pregnancy.
2. Condoms are effective to avoid HIV/AIDS.
3. Condoms can be used to avoid pregnancy.
4. Family planning is bad because it destroys the organ’s functioning. (R)
5. Sexually transmitted diseases and AIDS only happen to homosexuals and prostitutes. (R)
6. Only husband can decide whether to participate in family planning. (R)
7. People need more money to participate in family planning. (R)
8. Contraceptives are hard to find. (R)
9. Participants of family planning come only from rich people. (R)
10. Hysterectomy is a permanent method of family planning. (R)
11. Participants of family planning give better education to their children. (R)
12. IUDs can cause perforation of the uterus. (R)
13. Participants of family planning give more care and love to their children.
14. Participants of family planning have more time for other activities.
15. Abortion is one method of family planning. (R)
16. After use of IUDs, women cannot have children ever again. (R)
17. Lack of salt avoids pre-eclampsy. (R)
18. Limit food and drink to avoid a large baby. (R)
19. Calcium supplementation tablets to avoid cramps. (R)
20. Lactating mother should not eat fish or egg. (R)
21. Partograf should be used with complicated pregnancies. (R)
22. Partograf helps midwife make decisions during child birth.
23. Women should do PAP smear.
24. Shaving of the pubis is a routine activity. (R)
25. Washing hands is a practice to avoid cross-contamination.
26. Magnesium sulfate therapy is more effective than Diazepam to manage convulsion on pre-eclampsy.
27. Iron supplementation and folic acid are effective to decrease anemia during child birth or 6 weeks after.
28. Needle and swab are only to be used once.
29. Ask mother to take long and deep breath during the child birth process. (R)
30. Use hand gloves before touching injured skin, mucous, blood or other body fluid.
31. Use protective equipment such as glasses, masks, apron every time during work.
32. Cauterization of vesica urinaria is a routine activity. (R)
33. Torn hand gloves cannot be used anymore.
34. Problems at childbirth can be serious.

Note. IUDs = intrauterine devices.